Geochemical Constrains on Nature of Source Region of The Late Permian Emeishan Continental Flood Basalts, SW China

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The Emeishan Large Igneous Province (ELIP) in SW China (Sichuan, Yunnan, and Guizhou Provinces) comprises the Emeishan Continental Flood Basalts (ECFB) and associated mafic-ultramafic intrusions[1,2]. The ECFB covers an area of at least $5*10^5 km^2$ and includes the Eastern and the Western Parts separated by a major fault. The Western Part lies in the Eastern Margin of the Tibetan Plateau, whereas the Eastern Part lies in the Western Margin of the Yangzte Block. The volcanic successions include both marine and terrestrial rocks in the Western Part, whereas there are only terrestrial rocks in the Eastern Part.

The volcanic rocks have variable SiO_2 ranging from 43.6 to 52.1wt% and MgO from 5.4 to 23.1wt%, Al_2O_3 from 5.0 to 12.6wt%, and (K_2O +Na_2O) from 0.69 to 6.48wt%. SiO_2, Al_2O_3, and (K_2O+Na_2O) exhibit negative correlations with MgO, whereas transition metals (Ni, Cr, and Co) show positive correlations with MgO. With the decreasing of MgO, CaO increases from 6.3 to 11.1wt%, and then decrease to 6.7. These correlations and presence of phenocrysts (olivine and clinopyroxene) suggest fractional crystallization of olivine and clinopyroxene. The linear correlations between Zr, Nb, and La suggest that the crustal contamination is not important. The primitive-mantle-normalized trace element patterns show that the ECFB are enriched in HSFE, LILE and LREE, similar to OIBs. The ECFB have isotopic ratios ($^{143}Nd/^{144}Nd$=0.51229~0.51276 and $^{87}Sr/^{86}Sr$= 0.70480~0.70647)[3] plotted within the bulk silicate Earth field, different from HIMU, EM-1 and EM-2 OIBs. These isotopic ratios imply that the ECFB originated from a homogeneous, primitive lower mantle, consistent with a mantle plume. However, the incompatible element ratios, such as Zr/Nb (7~10), Th/La (0.1~0.15), and Rb/Nb (0.9~1.7), are different from that of primitive mantle, N-MORB, and continental crust, but are similar to EM-1 OIB. The mantle source of the EM-1 OIB was significantly contaminated by pelagic sediment components because of the recycling of subduction slab[3].

In order to explain the geochemical features of the ECFB, Chung et al.[4] proposed that the asthenospheric magma was mixed with a small-volume lamproitic melt derived from the lithospheric mantle. This model is not considered valid as lamproites are not identified in the region, and the K_2O concentrations of the ECFB are low. We propose that the original melts produced by the mantle plume are contaminated through interaction at shallower depth with a lithospheric mantle. The lithospheric mantle beneath the Yangzte Block was enriched through metasomatim by introduction of a recycled residual slab before the eruption of the Late Permian ECFB. This enriched domain might be due to introduction of oceanic slab and subducted sediment or mixtures[5]. A large proportion of the continental lithosphere have been modified by subduction-related fluids, which have sediment-derived signature[6]. The Western Margin of the Yangzte Block was an active island arc above a subduction zone during the Neo-proterozoic time[7,8,9]. This subduction might have caused a large scale recycling of subducted slab. During this subduction, sediments, rich in incompatible elements, and fluids may have rolled back into the lithospheric mantle. The primary HFSE (Nb, Ta, Ti, etc.)-rich melts were derived from the lower mantle, migrated to a shallower depth, and reacted with the lithospheric mantle. This reaction would break down the volatile-bearing minerals, such as phlogopite and amphibole. This process would decrease the melting temperature and enrich the melts in LILE, such as Ba, Rb, Th and U.

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